Prediction of Peak Energy Consumption and Carbon Emission in China Based on Variance Decomposition of Stochastic Frontier Production Function

Ruoxin Lin and Linyuan Fan*

College of Mathematics and Data Science, Minjiang University, Fuzhou 350108, China

fanlinyuan@mju.edu.cn

*corresponding author

Abstract: At present, the relationship between energy demand and supply in the international market has become increasingly tense, and energy problems have become more serious. Faced with the increasingly serious energy shortage situation, countries around the world have gradually begun to pay attention to energy conservation and emission reduction strategies, promoting the transformation of my country's high-energy-consuming industries from mainly relying on fossil energy to relying on clean energy, and realizing the diversified improvement of energy. The purpose is to predict the peaks of energy consumption and carbon emissions in China based on the variance decomposition of the stochastic frontier production function. In the experiment, the prediction results of carbon emission peak, the peak size of carbon emission under various scenarios, and the energy consumption carbon emission intensity are analyzed. The results show that the greater the intensity of energy reduction, the reduction of energy consumption carbon emissions The more difficult it will be, the carbon emission targets will be different in different scenarios.

1. Introduction

With the rapid improvement of energy demand in many fields, how to solve energy and environmental problems, and understanding the small carbon economy is very important to change the situation of national economic improvement [1]. At present, my country is the largest improving country in the world. The use of a large amount of fossil fuels has led to environmental problems such as global warming and greenhouse gas emissions becoming more and more common. Climate change is related to the survival and improvement of all people challenge.

Energy consumption, policies related to energy conservation and emission reduction have always been the focus of traditional energy economic research. Aftab S examines the environmental degradation problems faced by improving countries such as Pakistan. The use of non-renewable energy for system improvement is fundamental to degradation, and its consequences cannot be overemphasized. Therefore, it is to identify these conclusions, build integrative models and explore possible outcomes that may have a positive impact on reducing environmental problems. Exploring the strong link between carbon emissions, energy efficiency, and system improvement in models. Strengths and Interactions of Variables An autoregressive distributional test method for calculating the significance level of long-term relationships. The experimental results show that energy use, resource improvement, urban adaptation, R&D and forestry sectors have a significant positive impact on Pakistan's carbon emissions in the long and short term [2]. Demirtas M's research aims to the consumption, direct fertilizers and pesticides recommended for open-air cultivation of tomato puree. The main data were collected through a face-to-face survey with tomato paste manufacturers. Direct energy input associated with the power of diesel and lubricating oil for agricultural tractors used in agricultural activities, and indirect emissions associated with the production of fertilizers for antimicrobials for plant protection pressure and carbon dioxide in ketchup [3]. For the use of a large amount, the energy problem has become more serious. Therefore, we need to vigorously improve a low-carbon economy.

This paper studies the research background and significance of China's energy consumption, related concepts, and China's energy consumption and carbon emissions policy recommendations. Based on the variance decomposition of the stochastic frontier production function, this paper forecasts the peaks of carbon emissions. In the experiment, the prediction results of peak, the peak size of carbon emission in various scenarios, and the energy consumption carbon emission intensity are analyzed. There are differences in the predicted results due to differences in settings.

2. Research on China's Energy Consumption and Carbon Emissions

2.1. Research Background

With the improvement of society and economy in various countries and regions in the world, the global energy resources such as coal, oil and natural gas are becoming increasingly scarce, and the pressure to ensure world energy security is also increasing. Therefore, environmental problems continue to appear [4]. A question closely related to our country is: what measures should improving countries like China and India take in the future economic improvement? Moreover, our country The "Twelfth Five-Year Plan" has clearly pointed out that in the future social and economic improvement process, we must do our best to "conserve energy and reduce carbon emissions" [5-6]. It is a very solemn commitment and a very important social responsibility for all provinces and cities in my country to realize the goal of low-carbon economic improvement as soon as possible. All in all, low-carbon economy specifically refers to such an economic improvement model, which is based on a series of related ideas and connotations closely related to sustainable improvement, and on this basis, continuously improves new technologies and implements new policies, as well as on the industry. Various methods such as structural transformation or upgrading can be used to improve some new energy sources, so that the consumption of energy with high carbon emissions can be continuously reduced, and finally to achieve a win-win situation between protecting the natural ecological environment and economic and social improvement [7-8]. It can be seen that the current situation of my country's low-carbon economic improvement is not optimistic. It is very important and urgent to conduct analysis and research on the improvement of economy from the

perspective.

2.2. Research Significance

Whether the speed of economic improvement will gradually decrease with the continuous reduction of energy consumption, and whether it will impact the improvement of low-carbon economy in my country and other countries in the world, is undoubtedly an urgent problem that needs to be studied clearly [9-10]. Moreover, whether this problem is solved successfully or not has a very important role and significance in studying the static and dynamic relationship between energy consumption, carbon emission and economic growth and realizing the transition to a low-carbon economy. China relies on the consumption of energy such as coal, oil and natural gas, and coal consumption with pollution has always accounted for the largest proportion. This energy consumption improvement model will undoubtedly be difficult to change in a relatively long period of time. Therefore, in the process of realizing the transition, in order to achieve economic growth, we must not ignore the crisis of energy exhaustion and depletion caused by excessive use and consumption of energy, as well as the carbon emissions generated in the process of energy consumption. The serious environmental pollution and damage caused by these environmental problems and energy crises should not blindly reduce the amount of energy used in the life and production process, thus hindering the sustainable improvement of the social economy.

Therefore, at present, only by vigorously improving a low-carbon economy can the carbon dioxide's emissions in the economy and society be reduced, so that their content in the atmosphere can be maintained at a level suitable for human healthy living and living, so as to improve and stabilize the global environment and On this basis, the living environment of human beings can be completely changed [11-12]. Moreover, a large number of economic studies at this stage have proved that if there is excess carbon dioxide and other greenhouse gases in the atmosphere, it will cause catastrophic changes in the world climate, and even endanger people's survival and improvement in the future. However, economic growth, emissions are closely related and closely related. The consumption of energy as coal gas used in the process of social and economic improvement will generate a large amount of carbon dioxide gas [13]. Therefore, the research on the improvement of low-carbon economy from the perspective of energy consumption has very important practical and practical significance, and can also provide important theoretical and practical basis for the improvement of low-carbon economy in other cities in my country [14-15].

2.3. Concepts Related to Energy Consumption and Carbon Emissions

Energy consumption refers to the energy used and consumed by human beings in their daily life and production processes. The energy consumption refers to the gradually reduced energy due to use or loss [16]. The difference between the two is that energy consumption includes that part of energy consumption. Generally speaking, there are two main ways of carbon emissions in the process of human production and life. First, natural emissions. Second, artificial emissions. Carbon emissions are mainly caused by the burning of fossil raw materials in human production and life. Among them, the most important is due to the use and combustion of coal and oil. Therefore, if carbon emissions are to be continuously reduced, it is necessary to reduce the use of coal and oil in economic improvement. Specifically, it is to minimize the use of high-carbon-emitting fuels such as coal and oil, so as to continuously improve new clean technologies, create new clean and green energy, and make full use of natural gas, wind energy, water and solar energy, and geothermal energy.

2.4. Policy Suggestions

According to the previous analysis of China's measurement, influencing factor decomposition and future carbon emission prediction, the following emission reduction measures for my country are proposed:

Increase support for low-carbon economy and optimize energy production and consumption patterns.

Due to the target requirements of them, my country urgently needs to change the energy consumption mode dominated by fossil energy and the economic improvement mode that does not pay attention to quality. Change the mode of production and consumption, and promote the optimized layout of the industrial structure. Technological progress has the most significant inhibitory effect on carbon emissions. To realize the transformation of economic improvement to high quality, it is necessary to rely on scientific and technological progress [17].

(2) Promote the optimization of energy structure and improve energy utilization efficiency.

Promoting the optimization of my country's energy structure is an inevitable requirement for reducing carbon emissions. my country's resource endowment determines that coal consumption has always accounted for the highest proportion of energy consumption. Improving the energy structure will inevitably cost a lot. The improvement of clean and efficient renewable energy is an important way to speed up emission reduction..

(3) Accelerating the construction of a national carbon emission market

Carbon emission rights trading is a back-end control that controls the total amount of carbon emissions. The introduction of a market-oriented mechanism is conducive to giving the market in resource allocation, forcing enterprises to speed up technological transformation, technological innovation and transformation and upgrading in energy conservation and emission reduction, which is conducive to the adjustment of energy consumption structure and improves the allocation efficiency of energy elements. It will not increase the burden on enterprises and ensure market vitality. Accelerate the construction of national trading platforms and expand the overall market capacity. Focus on energy-intensive and high-emission industries such as energy and petrochemicals, and effectively monitor carbon emissions in key industries [18].

(4) Enhance national awareness of energy conservation and emission reduction

From the analysis of the influencing factors of energy consumption carbon emissions in this paper, it can be seen that in the process of implementing the emission reduction strategy, in addition to the policy efforts of various government departments to increase emission reduction, the national awareness of emission reduction and engagement can also play an important driving role. Therefore, it is necessary to increase the publicity of energy conservation and emission reduction policies, apply the concepts, advanced technologies and methods to actual production and life, advocate the participation of the whole people, and change the production and lifestyle of high energy consumption.

(5) Low-carbon improvement leads rural revitalization.

Rural revitalization is one of the key tasks after my country's comprehensive poverty alleviation. Integrate relevant policies for the improvement of low-carbon economy in rural areas, combine the improvement of clean energy in rural areas, environmental governance, and policies to achieve the "dual carbon goals" to form a clean energy policy system that helps rural revitalization, and improve the role of low-carbon policies in rural areas. Implementation efficiency.

3. Investigation and Research on Prediction of Peak Energy Consumption and Carbon Emission in China Based on Variance Decomposition of Stochastic Frontier Production Function

3.1. Data Collection

Under the three scenarios of China's carbon emission in three situation, according to the forecast data of GDP, energy consumption, population, technological level and energy structure in each stage from 2025 to 2030, use the stochastic frontier production function Predict possible future energy consumption and carbon emissions outcomes in China.

3.2. Stochastic Frontier Production Function

The technical efficiency production function represent the relationship between the combination of various production factors and the maximum output that can be produced within a certain period of time and a given technical level, that is, it reflects a technical relationship. Technical efficiency refers to the use efficiency of production factors, which reflects the gap between the actual production level and the frontier production level, and is equal to the ratio of the actual production level to the frontier production level. According to the above definition, Y^f represents the maximum possible output, X represents the factor input vector, β represents the parameter vector, and T represents the technical level. Therefore, the stochastic frontier production function is:

$$Y^f = f(X, \beta, T) \tag{1}$$

$$TE = Y / Y^f \tag{2}$$

Technical Efficiency (TE) takes a value between 0 and 1. When TE=0, Y=0, the actual production is completely inefficient; when TE=1, Y=1, the actual production reaches a fully effective state.

4. Analysis and Research on Peak Forecast of Energy Consumption and Carbon Emissions in China

4.1. The Forecast Results of China's Energy Consumption and Carbon Emission Peak

This paper makes predictions based on the high carbon scenario, baseline scenario and low carbon scenario. According to the forecast data of GDP, energy consumption, population, technological level and energy structure in each stage from 2025 to 2030, the function is used to predict the size and year of the carbon emission peak in the future. And compare the size and change law of carbon emission peak. The specific prediction results are shown in Table 1 and Figure 1:

Table 1. China's forecast results for 2025-2030 (unit: 100 million tons)

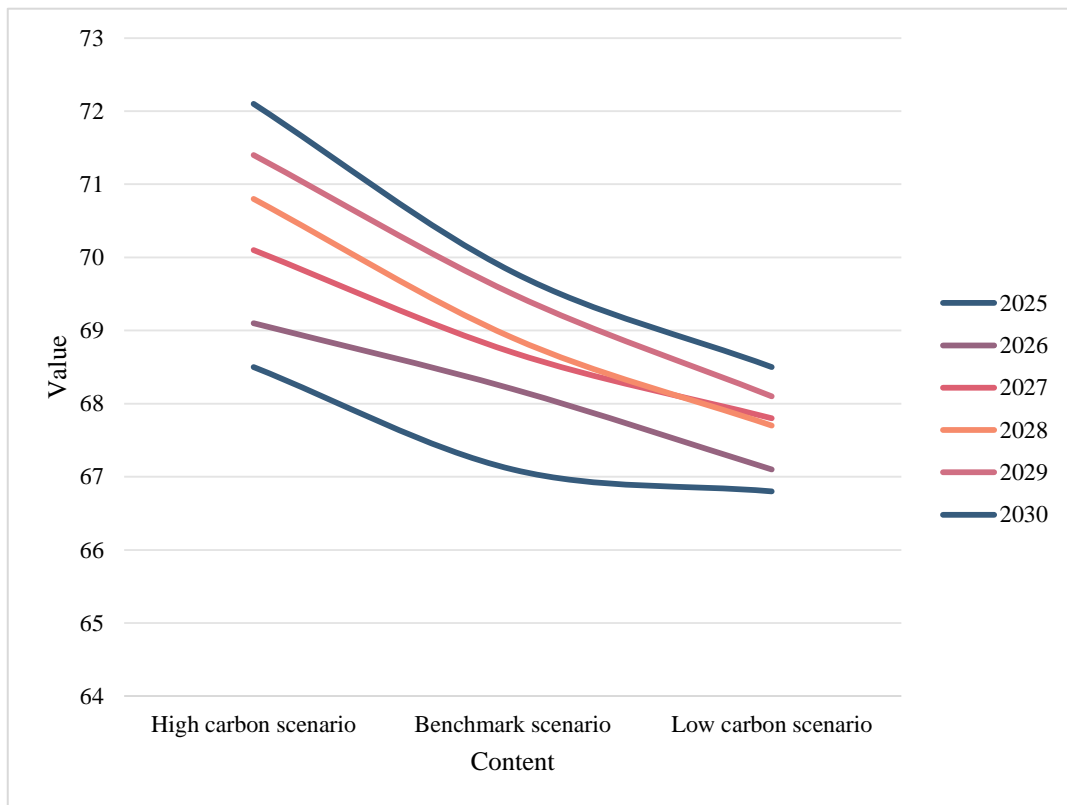| A particular year	2025	2026	2027	2028	2029	2030
High carbon scenario	68.5	69.1	70.1	70.8	71.4	72.1
Benchmark scenario	67.1	68.2	68.7	68.9	69.5	69.8
Low carbon scenario	66.8	67.1	67.8	67.7	68.1	68.5

Figure 1. Comparison chart of forecast results for 2025-2030

4.2. Analysis of the Peak Size of China's Carbon Emissions under Various Scenarios

Through Table 1 and Figure 1, we can intuitively see the amount under the three scenarios and the peak size of different scenarios. The following table shows the peak size of China's carbon emissions under various scenarios. As shown in Table 2 and Figure 2:

Table 2. Peak carbon emissions size and occurrence year of energy consumption in China from 2025-2030

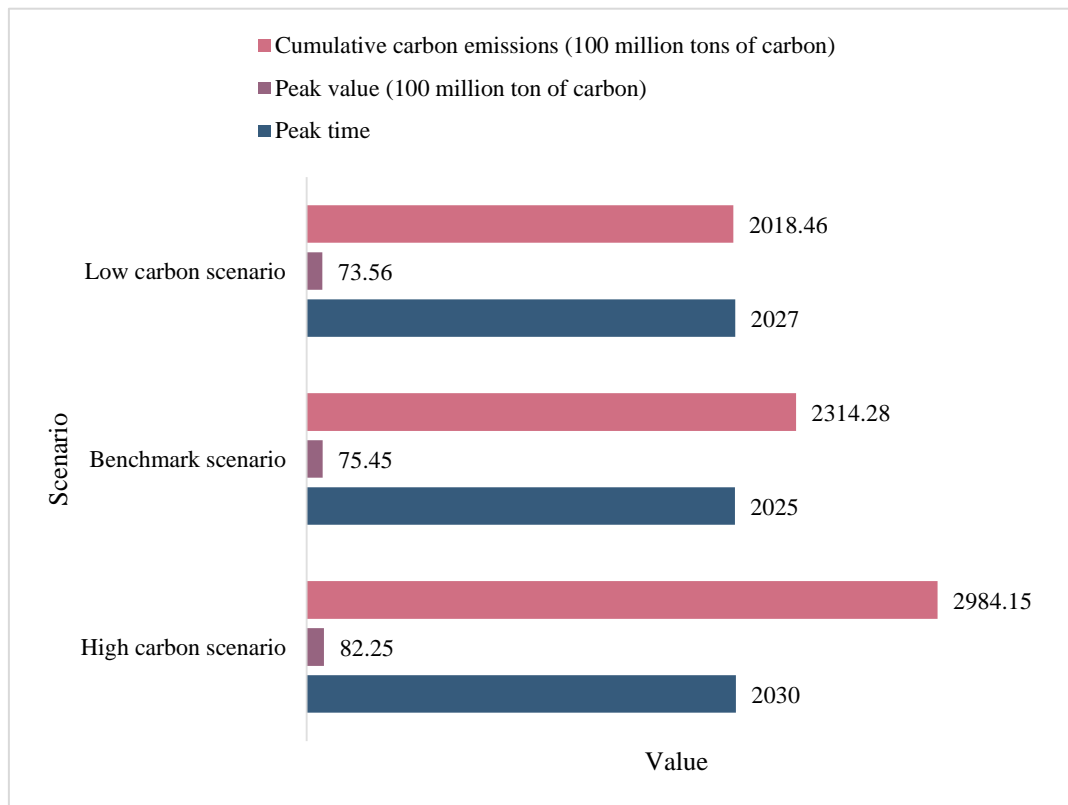| Improvement scenario	Peak time	Peak value (100 million ton of carbon)	Cumulative carbon emissions (100 million tons of carbon)
High carbon scenario	2030	82.25	2984.15
Benchmark scenario	2025	75.45	2314.28
Low carbon scenario	2027	73.56	2018.46

Figure 2. Comparison of China's peak energy consumption from 2025-2030

The experimental results show that due to the differences in GDP, energy consumption, population, technological level and energy structure growth rate settings in different scenarios, the predicted total carbon emissions of each energy consumption, the peak time and size of carbon emissions are also different. Under the high carbon scenario, the baseline and the low carbon scenario, the peak time of China's energy consumption carbon emissions will be in 2025, 2027 and 2030, respectively, and the corresponding peak sizes are 8.225 billion tons of carbon, 7.545 billion tons of carbon and 7.356 billion tons of carbon. According to the forecast results. In the baseline scenario, this goal cannot be achieved without taking more mandatory measures without accelerating the optimization of the energy consumption structure. Under the background that the new crown epidemic has a great impact on the global economy, if the focus is on the speed of economic improvement without further optimizing the economic improvement mode, if the investment in scientific research is low, and the technical level is improved slowly, and the promotion of energy structure optimization is insufficient, then energy consumption carbon Emissions will have a lot of room to grow. The results of the comparative analysis of the three scenarios also show that the greater the intensity conservation. The decrease shows that my country's energy conservation and emission reduction work has a long way to go, and it must continue to increase efforts. Once relaxed, it will cause a rebound in carbon emissions.

4.3. Analysis of Carbon Emission Intensity of Energy Consumption

According to the carbon emission forecast results, the carbon emission intensity can be further calculated and analyzed, as shown in Table 3:

Table 3. Carbon emission intensity and per capita carbon emission of China's energy consumption from 2025 to 2030

Year	Carbon emission intensity		
	High carbon(Ton carbon / ten thousand yuan)	Benchmark scenario(Ton carbon / ten thousand yuan)	Low carbon scenario(Ton carbon / ten thousand yuan)
2025	2.1345	1.7896	1.5369
2026	2.1078	1.6752	1.6143
2027	1.9878	1.5874	1.5670
2028	1.8759	1.4687	1.4314
2029	1.8654	1.4579	1.4136
2030	1.7835	1.3587	1.2178

From the perspective of carbon emission intensity from 2025 to 2030, under the three scenarios of high carbon, baseline and low carbon, the carbon emission intensity of China's energy consumption in 2030 will reach 1.7835 tons of carbon per ten thousand yuan, 1.3587 tons of carbon per ten thousand yuan and 1.3587 tons of carbon per ten thousand yuan, respectively. 1.2178 tons of carbon per 10,000 yuan, a decrease of 60.45%, 66.75% and 68.54% respectively compared to 2025. At this time, China's carbon emission reduction target is by 65%-70% compared with 2025. Under the same high carbon scenario Failed to complete this established target, the baseline scenario reached a high level of completion, while the low-carbon scenario exceeded the highest target of reducing carbon emission intensity by 67% and exceeded the emission reduction target.

5. Conclusion

Under the background of my country's increasingly severe carbon emission reduction situation, through the forecast of China's peak, in-depth analysis of residential energy consumption and carbon emissions, regional emissions and other energy and economic issues. At this stage, the use of carbon emission trading in my country is still in its infancy and has not yet formed a scale. The coverage of the trading field is relatively narrow, and the relevant laws and regulations and trading systems are not perfect. Strengthen the top-level design of carbon market construction and clarify relevant laws and regulations. Clarify the scope of responsibilities and regulatory standards of the agencies and regulatory authorities for the investigation and statistical work of carbon emission data. At the same time, combined with advanced technologies such as satellite remote sensing and big data, a multi-scale model for rapid and accurate carbon emission estimation has been established, and an accurate measurement of carbon emission reduction has been made, and a scientific evaluation mechanism has been established.

Funding

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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